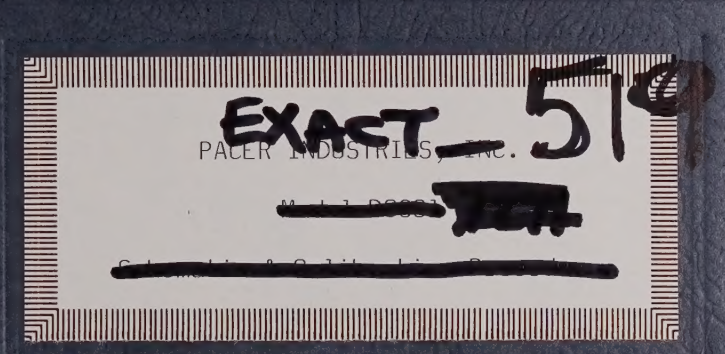

519

MP MASTER
MA30867

INSTRUCTION MANUAL

MODEL 519
S/N 16163 AND UP

FUNCTION GENERATOR

EXACT ELECTRONICS, INC.
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EXACT® electronics, inc.
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TWX 910-460-8811

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION 1

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

WAVEFORMS: Sine, square, triangle, positive sine, positive pulse, negative pulse.

DYNAMIC FREQUENCY RANGE: Main generator, 1 Hz to 11 MHz (0.01 Hz in search mode) AM/FM generator, 1 Hz to 1 MHz.

MODES OF OPERATION: Run, gate, trigger, pulse, burst, FM, AM, simultaneous AM-FM, ext. carrier.

SYNC OUTPUTS:

Main generator, square wave approximately 4V P-P open circuit. Approx. 100Ω output impedance.

AM/FM generator, square wave approx. 4V P-P, 100Ω output impedance. Located on rear panel.

FREQUENCY ACCURACY:

Main generator, ±2% of frequency range. 1 Hz to 1 MHz. ±(2% of setting plus 2% of frequency range) 1 MHz to 10 MHz.

AM/FM generator, 1 Hz to 1 MHz in three calibrated steps. Accurate within ±5%. Uncalibrated continuously variable between steps: variable has 100:1 range down from calibrated step.

OUTPUTS:

1. 50Ω output impedance. All waveforms 20V P-P open circuit. 10V P-P into 50Ω with exception of Positive Sine and Positive or Negative Pulses which are 10V peak open circuit, 5V peak into 50Ω. A full 80dB of attenuation is provided in 10dB steps with 20dB continuously variable (greater than 120dB utilizing carrier level in AM mode).
2. Separate selected AM-FM output approximately 2V P-P.

GATE AND TRIGGER MODES:

Input: DC coupled, input impedance approx. 1K. Trigger and gate signal requirements, manual or external voltage of approx. 1.2V for turn on. TTL compatible.

EXTERNAL AM INPUT:

Approx. 10V P-P for 100% modulation at full output. Frequency response, 1dB down at 1 MHz.

EXTERNAL FM INPUT:

Approx. 5V P-P for Maximum deviation. Slew rate limit approximately 0.1V/μsec.

EXTERNAL CARRIER INPUT:

Approximately 10V P-P for full output.

SINE WAVEFORM DISTORTION: $< 0.5\%$ 1Hz to 100 KHz (Typically $< 0.2\%$). No harmonics. $<$ 30dB down 100 KHz to 11 MHz.

SINE FREQUENCY RESPONSE: 0.1dB to 100KHz, 2dB to 10 MHz.

SQUARE WAVEFORMS: Rise and fall < 20 nanoseconds. Overshoot and ringing <5%.

TRIANGLE LINEARITY: 99% to 100 KHz.

D.C. OFFSETS: Variable ±5V into 50Ω, ±10V open circuit. Circuit will automatically limit (clip) signal if D.C. offset plus signal exceeds maximum voltage output.

FREQUENCY STABILITY:
0.05% of setting for 10 min.
0.25% of setting for 24 hrs.

AMPLITUDE STABILITY:
0.05% of maximum P-P amplitude for 10 min.
0.25% of maximum P-P amplitude for 24 hrs.

SYMMETRY (time): ±1% + 10 nS

POWER REQUIREMENTS:
Input Voltage - 115 VAC ± 10% or 230 VAC ± 10%
Frequency - 50 to 400 Hz
Power Consumption - Approximately 20W.
Other voltages available.

PHYSICAL CHARACTERISTICS
30.5cm wide X 8.9cm high X 37.5cm deep. Weight - 5.22kg. Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

OPTION "B" - 0.1 Hz - 11 MHz, Main generator

OPTION "G" - 0.01 Hz - 1 MHz, AM/FM generator

NOTE: (unless otherwise stated). Specifications apply 10% to maximum output voltage with instruments terminated into 50 Ω and do not apply in the Search Mode or AM Mode. Specifications are valid at 25°C ± 5°C warmup time of 30 min.

VERIFICATION OF SPECIFICATIONS

Following is a list of test equipment required to validate the specifications of the Model 519 AM/FM Generator.

Test equipment with accuracy equal to the following list of test equipment will be acceptable for specification validation.

Oscilloscope, DC to 50MHz
Plug-in, Differential 20mv/cm sensitivity
Counter/Timer, .1μsec time base
DVM, .01% accuracy
Harmonic Distortion Analyzer, less than 0.1% residual distortion
Spectrum Analyzer, 1KHz to 100MHz

NOTE: Allow 60 minutes for warm-up.

FREQUENCY ACCURACY:

Main Generator:

1. Set controls as follows:

RANGE	1K
MULTIPLIER	1.0
MODE	RUN
CARRIER	TRI
ATTENUATORS	OFF (OUT)
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

2. Connect the Counter/Timer to the Sync Output jack on the front panel with an appropriate coaxial cable to the A.C. input.

3. Observe time interval on counter of 1000μsec ± 20μsec.

4. Set Range to 100. Observe time interval of 10msec ± .2msec.

5. Set Range to 10. Observe time interval of 100msec ± 2msec.

6. Set Range to 1. Observe time interval of 1000msec ± 20msec.

7. Set Multiplier to .10. Observe time interval between 8.33sec and 12.50sec.

FREQUENCY ACCURACY, Main Generator (Continued)

8. Set Range to 10. Observe time interval between 833msec and 1250msec.
9. Set Range to 100. Observe time interval between 83.3msec and 125msec.
10. Set Range to 1K. Observe time interval between 8.33msec and 12.5msec.
11. Set Range to 10K. Observe frequency of 1KHz ± 200Hz.
12. Set Range to 100K. Observe frequency of 10KHz ± 2KHz.
13. Set Range to 1M. Observe frequency of 100KHz ± 20KHz.
14. Set Range to 10M. Observe frequency of 1MHz ± 220KHz.
15. Set Multiplier to 1.0. Observe frequency of 10MHz ± 400KHz.
16. Set Range to 1M. Observe frequency of 1MHz ± 20KHz.
17. Set Range to 100K. Observe frequency of 100KHz ± 2KHz.
18. Set Range to 10K. Observe frequency of 10KHz ± .2KHz.
19. Set Range to 1K. Observe frequency of 1KHz ± 20Hz.
20. Set Multiplier to .50. Observe frequency of 500Hz ± 20Hz.
21. Set Multiplier to 1.0.

AM/FM GENERATOR

1. Connect the Counter/Timer to the AM/FM Sync Output on rear panel with an appropriate coaxial cable to the AC input.
2. Set 100:1 VAR to CAL position.
3. Set AM/FM Range to 1MHz. Observe frequency of 1MHz ± 50KHz.
4. Set AM/FM Range to 10KHz. Observe frequency of 10KHz ± 500Hz.
5. Set AM/FM Range to 100Hz. Observe period of 10ms ± .5ms.
6. Set 100:1 VAR full CCW. Observe period > 1sec.
7. Set AM/FM Range to 10KHz. Observe period > 10ms.
8. Set AM/FM Range to 1MHz. Observe frequency < 10KHz.

FREQUENCY ACCURACY, AM/FM Generator (Continued)

9. Set 100:1 VAR to CAL and AM/FM Range to 10KHz.

TIME SYMMETRY

1. Connect the Counter/Timer to the Sync output jack on the front panel.
2. Set Range to 10K.
3. Set Multiplier to 1.0.
4. Set Counter/Timer to read time interval A to B and B to A. Observe time symmetry error $< 1\%$.
5. Set Range to 1K. Observe time symmetry error $< 1\%$.
6. Set Range to 100. Observe time symmetry error $< 1\%$.
7. Set Range to 10. Observe time symmetry error $< 1\%$.
8. Set Range to 1. Observe time symmetry error $< 1\%$.
9. Set Multiplier to .10. Observe time symmetry error $< 1\%$.
10. Set Range to 1K.
11. Set Multiplier to 1.0.

FREQUENCY STABILITY

Observe that the frequency remains within 0.05% for 10 minutes.

SYNC OUTPUT

1. Connect oscilloscope to the Sync output on front panel with an appropriate coaxial cable.
2. Observe square wave of approximately 2V P-P open circuit.
3. Connect oscilloscope to the AM/FM Sync output on rear panel.
4. Observe Sync pulse approximately 2V P-P open circuit.

CARRIER OUTPUT

1. Set amplitude to MAX. Connect the main output to the oscilloscope with a 50Ω coaxial cable terminated into 50Ω.
2. Observe Tri > 10V P-P.

CARRIER OUTPUT (Continued)

3. Switch through square, triangle and sine waveform, observing > 10V P-P amplitude.

4. Switch to negative square, positive square, and + sine observing > 5V peak amplitude.

5. Remove 50Ω terminator and observe > 20V P-P open circuit for square, triangle and sine waveforms and > 10V peak for positive and negative square and + sine.

6. Add 50Ω terminator, set attenuator 10dB, 20dB, 30dB, 40dB, 50dB, and 60dB and observe corresponding attenuation.

7. Rotate amplitude vernier and observe another 20dB of attenuation.

8. Set amplitude to MAX, attenuator to 0dB. (out)

GATE AND TRIGGER MODES

1. Set:

MODE	GATE
START LEVEL	0

2. Monitor output with oscilloscope.

3. Apply signal at Trig input jack, increase signal and observe main generator runs at approximately 1.2V of signal.

4. Depress Manual pushbutton and observe generator runs when button is depressed.

5. Set:

MODE----------TRIGGER

Apply signal at trigger input. Increase signal and observe main generator produces one complete cycle when trigger input rises to approximately 1.2V.

6. Depress Manual pushbutton and observe one complete cycle each time the Manual pushbutton is depressed.

SINE WAVE DISTORTION

1. Set:

MODE	RUN
RANGE	10K
MULT	1.0
AMPLITUDE	MID RANGE
FUNCTION	SINE

SINE WAVE DISTORTION (Continued)

2. Connect distortion analyzer to the output, terminated into 50Ω. Measure sine distortion of < .5%, typically .3%.

3. Set Range to 100K and measure sine distortion < .5%.

4. Set Range to 10M. Connect spectrum analyzer to main output jack and measure harmonic content. Observe no harmonics < 30dB down.

SINE FREQUENCY RESPONSE

1. Set Range to 10K.

2. Connect oscilloscope to output terminated into 50Ω.

3. Observe sine wave amplitude.

4. Set Range to 100K. Observe sine amplitude drop < .1dB.

5. Set Range to 10M. Observe sine amplitude drop < 2dB.

SQUARE WAVEFORM

1. Set:

RANGE	1M
FUNCTION	SQUARE
AMPLITUDE	MAX

2. Connect output through a 50Ω coaxial cable terminated into 50Ω to the oscilloscope.

3. Observe risetime and falltime of square < 20ns at main output.

4. Observe overshoot and ringing <5% of P-P amplitude.

D.C. OFFSET

1. Set Range to 1K, amplitude vernier to MIN.

2. Rotate D.C. offset switch and observe D.C. level shift ± 5V into 50Ω.

3. Remove terminator and observe D.C. level shift ± 10V open circuit.

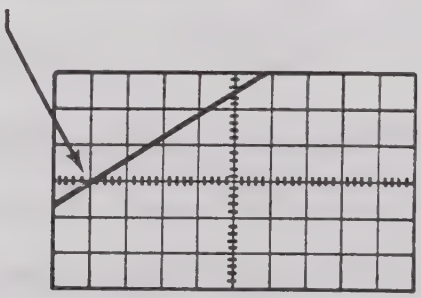
NOTE: D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

AMPLITUDE STABILITY

1. Set amplitude to MAX, D.C. offset to OFF, function to TRIANGLE.
2. Connect output through a 50Ω coaxial cable terminated into 50Ω.
3. Set plug-in sensitivity to 20mv/cm.
4. Measure accurately the positive peak of triangle and negative peak of triangle and record.
5. Wait 10 minutes and measure positive and negative peaks again. Observe amplitude change <10mv.

TRIANGLE LINEARITY

1. Connect the output to the differential plug-in through a 50Ω coaxial cable terminated into 50Ω.
2. Adjust oscilloscope to obtain one-half cycle of triangle across full horizontal grid on oscilloscope CRT.
3. Set differential plug-in sensitivity at 20mv/cm.
4. Adjust comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below:



5. Record reference voltage using DVM accurate to 1mv.
6. Adjust comparison voltage until slope of triangle intersects next major horizontal grid mark.
7. Record accurately the new reference voltage.
8. Repeat to obtain as many points as desired.

TRIANGLE LINEARITY (Continued)

9. Calculate linearity and observe linearity is 99% or better.

NOTE: Horizontal time base accuracy of oscilloscope and accuracy of DVM are important to obtain meaningful data.

SECTION 2

OPERATING INSTRUCTIONS

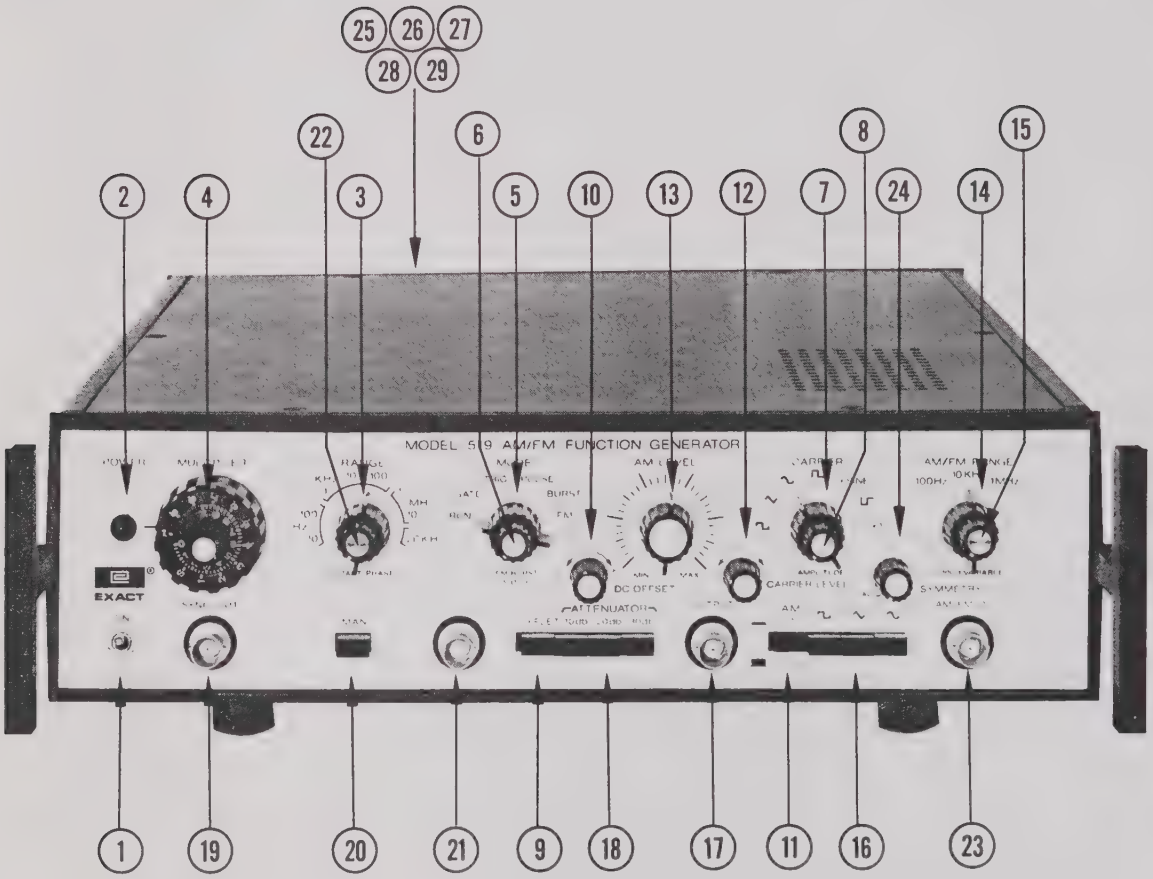


FIGURE 2.1.1.
FRONT AND REAR PANEL
FAMILIARITY

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

1. POWER ON/OFF SWITCH - Connects line voltage to the instrument.

2. PILOT LAMP - Visual indication when instrument is on.

3. RANGE SWITCH - Selects the desired range of CARRIER frequency.

4. MULTIPLIER - provides calibrated fixed steps between range settings. Each step equals 10% of range setting. The vernier dial provides variable frequency adjustment between fixed steps.

   The "S" position on the fixed step MULTIPLIER dial places the MULTIPLIER in the search mode. The search position allows the vernier dial complete control of the frequency over a three decade range.

5. MODE SWITCH - Selects the desired mode of operation.

   RUN MODE - The carrier generator will free run continuously.

   GATE MODE - The carrier generator will stop running. The generator will free run when an external signal is applied at the EXTERNAL TRIGGER INPUT or when the MANUAL PUSHBUTTON is depressed.

   TRIG MODE - The carrier generator will stop running. The generator will run for one complete cycle from an external signal or each time the MANUAL PUSHBUTTON is depressed.

   PULSE MODE - The PULSE MODE is similar to the TRIG MODE above. The AM/FM Generator will trig the carrier generator "ON" for one complete cycle at the AM/FM Generator rate.

   BURST MODE - The AM/FM Generator is connected internally to gate the carrier generator "ON" and "OFF" at the AM/FM Generator rate.

   FM MODE - The AM/FM Generator will frequency modulate the carrier generator internally when in the FM MODE.

6. FM/BURST WIDTH - Provides adjustment of the FM (sweep) width when in the FM MODE and burst width in the BURST MODE.

7. CARRIER SWITCH - Selects the desired carrier or output waveform desired. The EXT position allows the use of an external carrier or waveform.

8. AMPLITUDE - Provides > 20dB variable attenuation of the output signal. Amplitude control has no effect on carrier level or AM level adjustment.

FRONT PANEL FAMILIARITY (Figure 2.1.1) Continued

9. DC OFFSET SW - When switched on enables the variable control.

10. DC OFFSET - When switched on, provides variable control of the D.C. level of the output waveform.

11. AM SWITCH - Allows amplitude modulation of the selected carrier waveform.

12. CARRIER LEVEL - When in the AM MODE, this control provides complete adjustment of the Carrier Amplitude from Max Pos through "Null" to Max "Neg". 180° phase shift occurs from Max + to Max - setting. May be utilized as a variable phase control.

13. AM LEVEL - This control adjusts the amount of AM signal applied to the modulator. The desired amount of modulation is adjusted by means of the CARRIER LEVEL and/or the AM LEVEL controls.

14. AM/FM RANGE - Selects the desired frequency range of the AM/FM generator.

15. 100:1 VARIABLE - Provides variable adjustment of AM/FM frequency between fixed ranges. This control allows adjustment over a two decade range or 100:1.

16. AM/FM FUNCTION - A SQUARE, TRIANGLE, or SINE WAVEFORM may be selected to amplitude modulate the carrier waveform selected by the CARRIER SWITCH.

17. OUTPUT - BNC output connector providing 50Ω output impedance for connection to external equipment.

18. ATTENUATOR - A pushbutton attenuator providing a 10, 20, and 30db PAD for a total attenuation of 60db in 10db steps.

19. SYNC OUT - Provides a SQUARE WAVE for syncronizing external equipment to the Carrier Generator.

20. MANUAL PUSHBUTTON - The MANUAL PUSHBUTTON allows manual gating and triggering of the Carrier Generator in the GATE and TRIG MODE of operation.

21. EXTERNAL TRIGGER INPUT - When in the GATE and TRIG MODE, the Carrier Generator may be externally gated or triggered by application of an external signal at the EXTERNAL TRIGGER INPUT.

22. START LEVEL - When the carrier generator is in the gate, trig, pulse or burst mode of operation, the start level provides adjustment of the start phase over a ± 90° range.

23. AM/FM OUT - BNC output of selected AM/FM generator signal.

24. SYMMETRY - Control used to vary the time of the positive slope or logical portion of the selected AM/FM generator signal.

FRONT PANEL FAMILIARITY (Figure 2.1.1) Continued

25. V:f - A voltage output which is at all times proportional to the carrier frequency.

26. EXTERNAL FM INPUT - Provides external control of frequency for FM, sweeping, frequency shift keying, D.C. frequency control, etc.

27. EXTERNAL AM INPUT - When in the AM Mode, an external signal may be used to AM the Carrier Waveform selected. The AM level must be set to min. to avoid mixing of the internal and external AM signals, unless mixing is desirable.

28. EXTERNAL CARRIER INPUT - An external carrier or signal may be used when the CARRIER SWITCH is in the EXT position. Amplitude modulation of this external waveform is easily accomplished utilizing the AM/FM Generator.

29. AM/FM SYNC OUTPUT - Provides a square wave for syncronizing external equipment to the AM/FM Generator.

2.2.0 FIRST TIME OPERATION

Plug the power cord into the proper source of 117V AC or 230V AC 50-400Hz and turn on the power switch.

NOTE: It is recommended that the rear panel chassis ground and circuit ground be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

Set controls as follows:

RANGE	10K
MULTIPLIER	1.0
MODE	RUN
FUNCTION	∿
AMPLITUDE	MAX
ATTENUATOR	0dB (OFF)
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

FIRST TIME OPERATION (Continued)

1. Connect the main output through a 50Ω coaxial cable into a 50Ω terminator to a suitable oscilloscope. A 10KHz 10V P-P triangle waveform should be observed under these conditions.

2. Switch the Function switch through its various output waveforms.

3. The frequency may be selected by the Range switch and/or the Multiplier dial.

4. Switch the D.C. Offset switch ON and observe the waveform D.C. level may be adjusted as desired.

   NOTE: Reduce output amplitude while changing D.C. offset to prevent saturation of waveform.

5. Observe the output amplitude can be adjusted over its 80dB of dynamic range by the Amplitude vernier and the pushbutton attenuator.

GATE MODE

6. Place the Mode switch in the Gate position. Observe the main generator is now locked out. Observe the output while depressing the Manual pushbutton. The generator will free run as long as the pushbutton is depressed.

7. Rotate the Start Level control and observe the lockout level may be adjusted to the desired level or phase.

   NOTE: The generator will free run if the Start Level is rotated too far (90 degree phase shift).

TRIG MODE

8. Set the Main Mode switch to the Trig position. Observe one complete cycle each time the Manual pushbutton is depressed.

PULSE MODE

9. Set the Mode switch to Pulse.

   Set controls as follows:

FUNCTION	SQUARE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2ms/cm

FIRST TIME OPERATION (Continued)

Trigger scope from rear panel AM/FM Sync output.

The generator is now being triggered by the AM/FM Generator, providing a pulse output.

Observe that the carrier generator Range and Multiplier controls vary the pulse width. The repetition rate is variable by varying the AM/FM frequency.

BURST MODE

10. Place the Mode switch to Burst. The main generator is now being gated by the AM/FM Generator, producing a burst (more than one cycle) at the output.

Set the generator controls as follows:

FUNCTION	SINE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2ms/cm

Trigger the scope from AM/FM Sync output on rear panel.

Observe by adjusting the FM/Burst width and AM/FM frequency the burst "on" and "off" time may be varied. The frequency of the main generator determines the frequency of each cycle in the Burst.

FM MODE

11. In the FM Mode, the AM/FM source is connected to the FM input internally via the FM/Burst width potentiometer.

Set controls as follows:

MODE	FM
RANGE	10K
MULTIPLIER	.10
CARRIER	TRI
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	100Hz
100:1 VAR	FULL CCW (1Hz)
FM/BURST WIDTH	MID RANGE
AM/FM FUNCTION	∧∨

FIRST TIME OPERATION (Continued)

Observe the main generator triangle is being swept about the center frequency 1KHz.

Observe the FM width change while adjusting the FM/Burst width control.

Observe the FM sweep rate change while adjusting the AM/FM frequency.

AM MODE

12. Amplitude Modulation

Set controls as follows:

RANGE	100K
MULTIPLIER	1.0
CARRIER	∿
AMPLITUDE	MAX
D.C. OFFSET	OFF
MODE	RUN
AM/FM RANGE	10K
100:1 VAR	CAL
AM LEVEL	MAX
AM	ON
AM/FM FUNCTION	∿

100%:

Connect an oscilloscope to the output. Trigger the oscilloscope from the AM/FM sync output on the rear panel.

Adjust the Carrier level until 100% modulation is obtained.

Select TRI and SQ with the AM/FM Function switch and observe the carrier modulation corresponding to the waveform selected.

SUPPRESSED CARRIER

Set the AM level to min. Adjust the carrier level for a Null at the output.

AM/FM Function to ∿.

Set the AM Level to Max and observe suppressed carrier Modulation.

2.3.0 OPERATING PROCEDURE

NOTE: Regarding the Kelvin-Varley divider frequency multiplier vernier: The vernier frequency range of the Model 519 covers three decades. The upper limit of the three decades is selected by the RANGE selector. The "S" position on the outer dial of the MULTIPLIER selector switch is the "Search" position, and allows the generator to be tuned over the entire three decades of range by the inner MULTIPLIER dial. In position other than "Search", frequencies in the upper decade can be "dialed in", with the inner MULTIPLIER dial covering 0.1 of the upper decade.

RUN MODE-UNMODULATED SIGNAL OUT

A. Insure that no connections have been made to the rear panel EXTernal FM IN connector. On the front panel, one Sine, Triangle, or Square modulation waveform push button should be activated, or "in". Place all other push buttons in the "out", or de-activated position. Select RUN with the MODE selector.

B. Select the desired output, or "carrier" frequency with the RANGE and MULTIPLIER selectors. The frequency selected is available as a constant amplitude square wave at the front panel SYNC OUT connector. This signal can be used as an external sync for oscilloscope presentations, or for frequency or period measurements on a counter/timer.

C. Select Sine, Square, or Triangle output waveform desired with the CARRIER selector. The waveform selected, at the frequency selected, is available at the front panel OUTPUT connector for oscilloscope displays, counter/timer operations, etc.

D. Adjust the output AMPLITUDE control as necessary. The AMPLITUDE control will provide $\approx$20db of range, with a maximum output of $\approx$10V P-P into a 50Ω load.

E. The ATTENUATOR push buttons will provide lower output levels if necessary. The AMPLITUDE and ATTENUATOR controls affect only the signal levels at the OUTPUT connector. 80db of range is provided, with a minimum output of 1.5mv into a 50Ω load.

NOTE: 50Ω coaxial cable and termination loads must be used to avoid wave shape distortion and frequency response deterioration of the OUTPUT signal.

OUTPUT OFFSETS

A. The OFFSET controls affect only the signal present at the OUTPUT connector.

2.3.0 OPERATING PROCEDURE (Cont.)

OUTPUT OFFSETS (Cont.)

B. The DC OFFSET control is activated by activating the OFFSET push button, and will provide positive or negative DC offset reference for the waveform. The output Sine, Triangle, or Square will be symmetrical about this reference.

With the OFFSET push button de-activated, the DC reference level is zero volts.

NOTE: Sufficient range is provided in the DC OFFSET control to cause output "clipping" under some conditions. The output DC offsets and output amplitudes will be simultaneously affected by the ATTENUATOR controls.

PULSE, +SINE, AND NEGATIVE PULSE CARRIERS

A. The positive PULSE waveform, selected by the CARRIER control, will divide the Square wave amplitude by two, clamp the negative peaks to the DC reference level selected by the DC OFFSET and OFFSET controls, and produce the resultant waveform at the OUTPUT connector.

B. The +SINE position of the CARRIER selector will perform the same signal conditioning as "A" above for the Sine wave.

C. The negative PULSE, selected by the CARRIER control, will divide the Square wave amplitude by two, clamp the positive peaks to the DC reference level selected by the DC OFFSET and OFFSET controls, and produce the resultant waveform at the OUTPUT connector.

EXTERNAL FM OPERATIONS

A. The rear panel EXTernal FM connector provides external control of the main generator's output frequency. Since the input is DC coupled, DC levels can be applied to offset the carrier frequency selected by the MULTIPLIER and RANGE controls, ramp signals can be applied for frequency sweep operations, or external signals can be used to Frequency Modulate the Main Generator output.

NOTE: Signals applied to the EXTernal FM connector are routed directly to the frequency control circuitry of the main generator, and are not affected by the front panel controls. During operations other than EXTernal FM, errors may develop if connections are made to the EXTernal FM connector.

B. A 0 to +5VDC signal applied to the EXTernal FM connector will cause the main generator frequency to shift from 0.001 of range, to 1.0 of range.

C. A 0 to -5VDC signal will cause a decrease from 1.0 of range to 0.001 of range.

2.3.0 OPERATING PROCEDURE (Cont.)

MODULATION GENERATOR OPERATION

A. Connect an oscilloscope's vertical input to the AM/FM OUT connector. Sync the scope from the rear panel AM/FM SYNC OUT. Place the SYMMETRY control in the CAL position, and the 100:1 VARIABLE fully Clockwise.

B. Select the desired Sine, Triangle, or Square modulation wave shape by activating the appropriate push button, and select the desired modulation frequency with the AM/FM RANGE selector. The oscilloscope should now display the selected waveform and frequency.

C. The SYMMETRY control can now be used to increase the period of the positive slope, or positive portion in the case of the square wave, of the selected waveform.

D. The 100:1 VARIABLE can be used to decrease the modulation generator output frequency up to a factor of 100:1.

PULSE MODE - INTERNAL, MANUAL, AND EXTERNAL TRIGGERS

A. Establish a carrier generator output signal as per the Run Mode procedures.

B. Establish the desired pulse repetition rate as per the Modulation Generator operations procedures.

C. Select PULSE on the MODE selector. Connect an oscilloscope's vertical input to the main generators OUTPUT, and sync the scope from AM/FM SYNC OUT. The oscilloscope will display a single 360° wave shape preceded and followed by a DC level. The DC level represents the instantaneous DC level of a point on the waveform at which the generator is started and stopped. The DC level is present when the generator is in a condition of "Lockout". The start/stop point on the waveform is adjusted with the START PHASE control. If phase angles of greater that +90° are selected, the generator may "free run".

D. For Manual pulse operation, insure that no connections are made to the TRIGger IN connector, and select TRIGger on the MODE selector. A pulse will be generated each time the MANual push button is depressed.

E. After the manual pulse, or trigger, mode has been established, an external signal can be applied to the TRIGger IN connector. A single cycle of the selected Carrier waveform will be generated with each positive transition of the signal applied to the TRIGger INput. (Scope Sync should be changed to the front panel SYNC OUT connector.)

2.3.0 OPERATING PROCEDURES (Cont.)

BURST MODE - INTERNAL, EXTERNAL, AND MANUAL GATE

A. Perform the Pulse Mode procedures "A","B", and "C".

B. Select BURST on the MODE control. Adjust the FM/BURST WIDTH control for the desired burst width.

NOTE: If the MANual push button is depressed in this mode, the Main Generator's OUTPUT will be gated on until the push button is released.

C. Insure that no connections are made to TRIGger IN, and select GATE on the MODE control. The Main Generator is now in the Manual Gate Mode. Depress MANual for an output, and release to re-enter lockout.

D. For External Gate operations, place the generator in the Manual Gate Mode, and apply a gating signal to the TRIGger IN connector. The FM/BURST WIDTH control will have no effect on the DC gate level. (Scope Sync should be changed to SYNC OUT.)

INTERNAL FM OPERATIONS

A. Establish the desired modulation frequency as per the Modulation Generator operating procedures. Connect the oscilloscope external sync to the AM/FM SYNC OUT connector on the rear panel.

B. Establish a carrier output as per the Run Mode operating procedures. Connect the OUTPUT connectors to the vertical input of an oscilloscope.

C. Select FM on the MODE selector. The oscilloscope will display the Frequency Modulated carrier with the oscilloscope synchronized to the modulating signal. Adjust the FM/BURST WIDTH control for the desired modulation level.

NOTE: Internal and external FM operations can be performed simultaneously. Care should be taken to insure that unwanted connections have not been made to the EXTernal FM input.

AM OPERATIONS - INTERNAL AND EXTERNAL

A. Establish the desired carrier frequency and wave shape as per the Run Mode procedures. Establish the Modulation frequency and wave shape as per the Modulation Generator operating procedures.

B. Connect as oscilloscope vertical input to the front panel OUTPUT connector, and sync the scope on AM/FM SYNC OUT.

2.3.0 OPERATING PROCEDURE (Cont.)

AM OPERATIONS - INTERNAL AND EXTERNAL (Cont.)

C. Adjust AM LEVEL to MINimum, and activate the AM ON push button. Adjust the CARRIER LEVEL control for the carrier amplitude and phase desired. (For suppressed carrier operations, adjust CARRIER LEVEL for a "null".) Adjust the AM LEVEL control for the desired amount of modulation.

D. For External AM operations, adjust the AM LEVEL control to MINimum, and apply an external modulating signal, at the desired modulation level, to the EXTernal AM input on the rear panel.

NOTE: Insure that no connections are made to the EXTernal AM IN connector when EXTernal AM operations are not being performed, or errors may result.

EXTERNAL CARRIER OPERATIONS

A. Select EXTernal on the CARRIER selector switch, and apply a carrier signal to the EXTernal CARRIER IN connector on the rear panel. Only the Internal and External AM modes will operate properly, Internal and External FM modes will not apply.

B. For external AM modulation of an external carrier, select EXTernal on the CARRIER selector and connect a carrier signal to the EXT CARRIER IN connector on the rear panel. Connect the modulating signal to the EXT AM IN connector, activate the AM ON push button, and adjust the AM LEVEL control to MINimum. The CARRIER LEVEL, AMPLITUDE, ATTENUATOR, and OFFSET controls can be used to condition the OUTPUT signal as desired.

SECTION 3

CIRCUIT DESCRIPTION

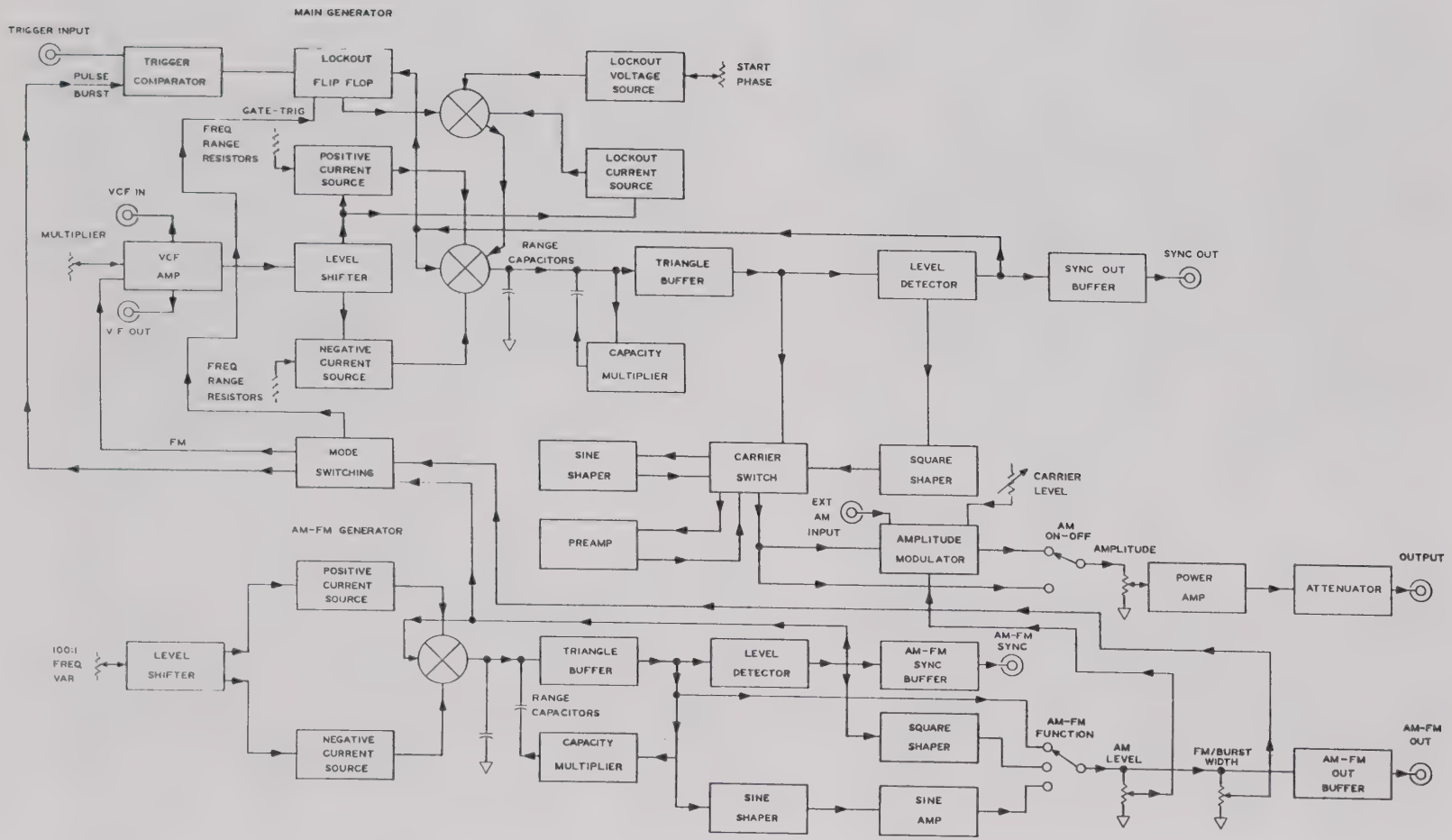


FIGURE 3.1.1.
BLOCK DIAGRAM

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

The basic generator loop utilized in this waveform generator consists of a pair of current sources alternately charging and discharging a timing capacitor. The triangular waveform generated in this timing capacitor is applied to a high input impedance triangle buffer amplifier which then applies the triangular signal to the bi-stable level detector. The output of this level detector is then fed back to alternately switch the current sources thus the loop is closed forming a free running generator. The level detector is used to switch the current sources at a predetermined point on the triangle thereby generating a constant amplitude triangle regardless of frequency of operation. Having generated a triangle of constant amplitude the frequency then is proportional to the timing capacitance and the current supplied to the capacitor from the constant current sources. Decade values of frequency are selected by decade selection of the timing capacitors and decade selection of the constant current sources. Variable frequency adjustment is accomplished by variable adjustment of the current sources through application of a DC voltage. For alternately charging and discharging the range capacitors one constant current source is a positive source and the other is a negative. In order that these can be externally controlled with a single DC voltage a pair level shifting amplifiers are supplied that convert a single input voltage to the voltages necessary to drive the positive and negative current sources. The positive and negative level shifting amplifiers are driven by the single VCF amplifier that can accept a signal either from the generator Multiplier dial or from an external DC voltage. The Multiplier dial receives its signal from a constant voltage amplifier called the VCF Amp.

This basic generator loop by nature provides a triangular waveform and a square waveform that can be processed and used as output signals to provide two waveforms. The triangular waveform can be processed through the sine shaper to provide a sinusoidal waveform. The triangular waveform available at the output of the triangle buffer can be applied directly to the preamp through the carrier switching network. This then provides the triangular output waveform. The square waveform from the level detection network is applied directly to the square amplifier which then goes through the carrier switch to the preamplifier. For sinusoidal operation the triangular waveform from the triangle buffer is supplied through the function switching network to the sine shaper. This waveform is then applied back through the function switching network to the preamplifier. The preamplifier utilized in this generator is used to boost the operating signal levels generated by the basic generator loop to something suitable for processing in the power amplifier. The preamp is also used to provide the offset sine wave which decreases the amplitude of the generated waveform to one-half and offsets it to a value that maintains one peak at 0 volts. The output of this preamp is applied directly to the amplitude potentiometer which selects the amplitude applied to the power amplifier. The power amplifier can accept not only this amplitude signal but offset signals from the external input or the variable offset control. The output of the power amplifier is directly applied to the step attenuator which can attenuate the signal in fixed db steps. The output of the attenuator is the main output connector for the generator. There are eight power supplies in this generator, four of them being the unregulated raw supplies available directly at the filter capacitors. This voltage is a nominal 30 volts which is stepped down through the positive regulators for a plus 20 volt supply and a minus 20 volt supply. The plus and minus 20 volt supplies are used to provide

3.1.0 BLOCK DIAGRAM (Continued)

voltage for the constant current sources as well as for the power amplifier. The plus and minus 20 volt raw supplies are regulated through the plus and minus 15 volt regulators to provide all the operating potentials necessary for operation of the other circuitry.

In order to lock out the main generator loop the application of the positive or negative current source for charging the timing capacitor is interrupted through the use of switching diodes and a Lock Out current source. The lock out current source is used to sink the timing current available from the positive or negative current sources and clamp the timing capacitor voltage to the Lockout Voltage source. The lock out current source derives its tracking signal from the positive level shifters in the main generator loop. This allows them to operate at a current that tracks at 2 times the current supplied by the positive and negative current sources. This prevents a lock out level shift for a change in generator frequency dial. In order that the generator can be made to always complete its last cycle of operation or complete the final portion of its cycle a lock out flip flop is used so that the application of the lock out current sources only occurs at the proper time. Operation of this flip flop is arranged such that any input or set signal will override the reset signal and a continuous application of the set signal will yield a continuous output such that the generator will run continuously. In order that both single cycle and a gated mode of operation can be realized, the mode switch selects whether the Run command can be coupled through in a DC form or AC coupled such that a single pulse is provided for each input command. The main run command overrides all others and provides for free running operation through activation of this flip flop. In order to condition the external input signals for gated and triggered operation a trigger comparator is used. The trigger comparator circuit is wired as a Schmitt trigger with appropriate feedback such that a reasonable amount of hysteresis is gained. This hysteresis provides for reliable triggering for both single shot and gated operation. The Manual trigger button will also apply the DC voltage necessary at the trigger comparator to initiate gate or trigger.

The trigger amplifier receives its input from the mode switching which selects whether the main generator is triggered from an externally applied trigger signal or from the internal AM-FM generator. This AM-FM generator is used to generate the Variable Symmetry ramp waveform used for frequency sweeping, for burst operation or amplitude modulation. For operation in the sweep mode the ramp voltage generated in the ramp generator is applied through the FM-Burst width control to the VCF Amp. An extra amplifier called the V:f amplifier is provided to monitor the voltage at the output of the VCF amplifier so that a voltage proportional to frequency is available.

The AM-FM generator utilized a basic generator loop very similar to the main generator. It uses alternate current sources charging and discharging the timing capacitors. A very high input impedance buffer amplifier is used to apply this signal then to the external loads for the ramp voltage and to the ramp level detector which is a bi-stable switch that controls the peak voltages of the waveform. The output then of this level detector is fed back to the current switch which selects either the positive current source or the negative current source. This connection closes the loop and provides a free running generator. Frequency changes are realized by changing the value of the range capacitors in 100:1 steps. Current Sources are

3.1.0 BLOCK DIAGRAM (Continued)

also controlled by a DC voltage that makes it continuously variable over a 100:1 range. This voltage is generated through the Level Shift Amplifier. The 100:1 Variable directly applies a voltage to the Level Shift Amplifier such that the voltage is proportional to frequency. The AM-FM generator also has a sine shaper and sine amplifier to produce any of the sine, square or triangle waveforms with Variable Symmetry. This can be used for AM, FM or Burst operation.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

The primary power for this instrument is supplied through the line cord to fuse F-100 which is selected for each voltage of operation. The primary power is then applied through the main power switch S-100 to different taps on the primary for different line voltages. Transformer T-100 steps down the operating potentials of the input primary power so that the proper voltage is developed through the usage of diode bridge D-100 - 103 and filter capacitors C-100 and C-110. This full wave center tapped bridge rectifier setup provides both positive and negative operating potentials of sufficient magnitude to be regulated through the usage of the plus and minus 15 volt regulators. Integrated circuit Q-120 has a self contained voltage reference and error amplifier. The output of this error amplifier is fed to series pass transistors Q-100 and Q-110 which enhances the current carrying capability of Q-120. Resistors R-102 and R-112 are current sensing resistors that allow Q-120 to reduce the output voltage of the supplies in the event the current reaches a predetermined value. The voltage feedback, necessary for the error amplifier, is enhanced through the usage of the voltage divider R-126 through R-127. The potentiometer R-126 and R-127 provide for a vernier adjustment in the power supply voltages. Diodes D-124 and D-125 are used to prevent accidental application of reverse voltages to the regulators. Capacitors C-102 and C-112 prevent the build up of transient voltages at the output of the supplies under varying load conditions. The instrument power indicator D-104 is operated from the regulated 15 volt supply. The second secondary winding is applied to the full wave bridge rectifiers D-132 and D-135. The resultant potentials are filtered by C-130 and C-170 to produce the nominal plus and minus 30 volts unregulated. Transistor Q-140 is used as a constant current source for the two series zener diodes D-130 and D-131. This reference potential from the zeners is sued directly as the base drive for the series pass transistor Q-130. Transistor Q-150 is used as a clamp amplifier to provide short circuit current limiting. If the voltage across the sensing resistor R-131 reaches a sufficient level to cause Q-150 to conduct the base drive to Q-130 is reduced accordingly by its clamping action. The -20 volt regulator is simply a mirror image of the +20 volt regulator where Q-180 is the constant current source, Q-160 is the clamp and Q-170 is the series pass transistor.

3.2.2 MAIN GENERATOR - FREQUENCY CONTROL (Figure 6.2.2)

The main generator frequency control can be from any of three signals. It can be an external voltage, an internal signal from the frequency multiplier or an internal signal from the AM-FM generator. The VCF Amp, Q-220C, is the summing point for any of these signals. Q-220A is used as a constant voltage reference for the main frequency dial. Q-220C is the VCF Summing

3.2.2 MAIN GENERATOR - FREQUENCY CONTROL (Figure 6.2.2) Continued

Amp and is used in conjunction with Q-210 as a level shifting network. Q-220D accepts this output and in conjunction with Q-230 does another level shift so that the signals at pin 3 of Q-310 and Q-280 are tracking signals of equal and opposite polarity and referenced to either plus or minus 15 volts. The voltage at pin 3 of Q-280 should vary between +10 and +15 volts and the voltage at pin 3 of Q-310 should vary between -10 and -15 volts over the full range of frequency control. Q-280 is used in conjunction with Q-260A and Q-260B to provide two positive current mode outputs one for the main timing and one for the lock out. Q-270 is a common base buffer amplifier. Q-310 is used in conjunction with Q-300 to provide a negative current mode output for the main timing. Q-290 is a common base buffer amp for this output. Q-1000 in conjunction with Q1010 is used as a variable voltage supply so that the triangle waveform developed at R-276 can be clamped through the diodes D-1000 - D1003 to a variable level. D-1004 and D-1005 accept the run, gate, and trigger commands from the lock out circuitry. D-270 and D-277 accept the square wave signal from the level detector circuit.

3.2.3 MAIN GENERATOR LOOP AND SINE SHAPER (Figure 6.2.3)

The alternate positive or negative current sources from Schematic 2 are applied to decade step values of capacitance through S-300D to produce decade frequency ranges. For very low frequency ranges the triangular waveform is amplified by Q-345 and Q-341 to produce a capacitance multiplication. Q-320 and Q-330 are used as a complimentary emitter follower buffer amplifier for this signal. Q-360A and Q-350A are used as a high impedance amplifier to buffer the triangle waveform for the level detector, sine shaper, and the pre-amplifier. Q-400A and Q-400B, a differential amplifier, is used to compare the triangle waveform peaks with a constant amplitude square waveform developed across R-402 by D-450 through D-453 and their current source resistors. Q-410 is a constant current source for Q-400A and B. Q-440 and Q-450, another differential amplifier, are used to provide high level square waveforms for positive feedback to make the level detector bistable and to provide the switching waveform for the timing current sources. These square waveforms are also used for resetting the lockout circuitry and driving the square switch for square output waveforms. The diode networks D-500 through D-52 also accept a triangle waveform from the triangle buffer. The transfer ratio of this network is non-linear and produces a sinusoidal waveform output from the triangle input.

3.2.4 LOCKOUT CIRCUITRY (Figure 6.2.4)

The lockout circuitry consists of a trigger comparator and a set reset flip flop. Integrated circuit Q-900 is connected as a high gain differential amplifier which accepts the trigger input signals at Q-900B. This signal is further amplified by Q-900C and D and applied to Q-910 and Q-920. Q-910 provides a high level output while Q-920 provides positive feedback to Q-900C creating hysteresis. Q-900E is used as a constant current source for the input amplifier Q-900B and A. The processed gate or trigger signal is then applied to the flip flop through a buffer amp Q-940. Q-950 accepts the input to the flip flop and Q-960 - Q-990 provides the positive feedback. Q-980 provides the output to control the clamp diodes for the lockout current sources.

3.2.5 MAIN GENERATOR SIGNAL CONDITIONING CIRCUITS (Figure 6.2.5)

The square wave signal from the main generator loop is applied differentially to transistors Q-700 and Q-710. These transistors drive a high level signal to the diode switching bridge D-707 - D-709. This bridge has an output that is selected by the carrier switch to be bipolar, positive or negative. The resultant square signal is then buffered through the complimentary buffer Q-720 and Q-730 for application to the power amplifier.

Transistors Q-760 and Q-770 provide the buffering amplification for the sync output signal.

The sine and triangle signals from the main generator loop and sine shaper are applied through S-500B to the preamplifier input transistors Q-530A and B. The preamplifier is a closed loop operational type with complimentary output buffers Q-580 - 590. Resistors R-583 and R-535 are the gain sealing resistors. The signal from the output of the preamplifier is then fed to the output amplifier.

3.2.6 OUTPUT AMPLIFIER (Figure 6.2.6)

The output amplifier is also a closed loop operational type amplifier where IC Q-800 is the low frequency and DC input channel. For higher frequencies the input is directly coupled to Q-820 and Q-840. The low frequency channel is a high gain input due to the use of two differential stages. Q-820 and Q-830 are a cascode connected amplifier and Q-840 and Q-850 are also a cascode connected amplifier. The output of these two complimentary stages is connected to the complimentary Darlington amplifiers Q-860 - Q-890. The output from the amplifier is extracted through R-882 - 884 which provide the series 50Ω output impedance. S-810B,C,D are used to switch the constant impedance attenuator circuitry.

3.2.7 AMPLITUDE MODULATION CIRCUITS (Figure 6.2.7)

The amplitude modulation circuitry uses the variable transconductance type of four quadrant multiplication. The modulation inputs from external or internal are applied to Q-1600 operational amplifier. This amp scales gain and DC so that these signals can be used by the level shifter. The level shifter conditions the AM signals for direct use by the variable transconductance element Q-1640. The carrier signal from the main generator is accepted by another level shifter Q1630A and B. The resultant signal is then directly applied to the variable transconductance element.

The resultant multiplied signal is then applied directly to the booster operational amplifier. Integrated circuit Q-1650 is the low frequency channel of this amplifier and the high frequency signals flow directly into the cascode pairs Q-1660 - 1670 and Q-1665 - 1675. The output from the booster amp is taken directly from the complimentary Darlington stages Q-1680 - 1690.

3.2.8 AM-FM GENERATOR (Figure 6.2.8)

The AM-FM Generator is a sine, square, triangle generator completely independent of the main generator. Q-1500 is a level shifting amplifier that drives directly into the positive and negative current source inputs. Q-1505 and Q-1510 are operational current sources

3.2.8 AM-FM GENERATOR (Figure 6.2.8)

used to alternately charge and discharge the timing capacitors Q-1530A and Q1535 comprise the high impedance triangle buffer. The triangle output from this buffer is fed directly to the level detector at pin 2 of the integrated circuit Q-1535. The output of this differential amplifier is fed to another differential amp Q-1540 and Q-1545. The positive feedback occurs through D-1515 - 1518, a diode switching network creating a bistable level detector. The square wave output from the collector of Q-1540 is also fed to the current sources to alternately switch to opposing polarities creating the triangle waveform. The triangle waveform is also applied to the non-linear network of D-1550 - 1573. The resultant sine wave output is amplified by IC-1560. Q-1545 and Q-1550 comprise the AM-FM sync out buffer amp while Q-1570 and Q-1580 comprise the AM-FM output waveform buffer.

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